ESTIMATION OF 1-HOUR NOx IMPACT FROM CONSTRUCTION

Estimation of the 1-hour NO_2 impact from construction activities was based on the assumption that the actual NO_2 emission rates are 10% of total emissions of NOx. The NO_2/NO_x ratio of 10% is a conservative assumption for the actual ratio of NO_2 to total NO_x emissions for internal combustion engines (Flagan and Seinfeld, 1988). In addition, it was assumed that the remaining 90% of NO_x is emitted as NO and would not have sufficient time to be completely converted to NO_2 near the facility boundaries where the maximum impacts occur. Transport times to the areas of maximum construction impacts are on the order of 1 to 2 minutes, while half-life for NO in the atmosphere is estimated to be 5 days (Williamson, 1973). Assuming a first-order exponential decay, the portion of the directly emitted NO that converts from NO to NO_2 in 2 minutes can be estimated as follows:

Conversion equation: $NO_{2min.}/NO_o = \exp(-kt)$

$NO_{2min.}/NO_o$ = ratio of NO remaining to original NO concentration
k, rate constant = 9.63×10^{-5} min^{-1}
t, reaction time = 2 minutes

$NO_{2min.}/NO_o = \exp(-9.63 \times 10^{-5}\ min^{-1} * 2\ minutes) = 0.9998$

Amount of NO converted to NO_2 = 1 - $NO_{2min.}/NO_o$ = 1 – 0.9998 = 0.0002

The modeled NO_x impact was multiplied by 0.1 to account for the NO_2 fraction (10%) that is directly emitted as described above. The fraction of directly emitted NO (90%) that is estimated to convert to NO_2 in the short travel time (2 min) to the point of maximum impact was estimated by multiplying the conversion fraction estimated above. The converted NO_2 was then added to the directly emitted NO_2 contribution to obtain the 1-hour modeled NO_2 impact. A sample calculation of the estimated worst-case NO_2 impact is shown below. NO_2 concentrations for different distances and transport times from the construction site are shown in table following the sample calculation.

Modeled 1-hour NO_x impact:
2,518.1 $\mu g/m^3$

Impact of directly emitted NO_2 (10% of total NO_x):
2,518.1 $\mu g/m^3$ * 0.10 = 251.8 $\mu g/m^3$

Conversion of NO to NO_2 in the atmosphere at the point of maximum impact:

Conversion equation: $NO_{.}/NO_o = \exp(-kt)$
$NO_{.}/NO_o$ = ratio of NO remaining to original NO concentration
Given a half life of 5 days (7,200 minutes), $NO/\ NO_o = 0.5 = \exp(-k*7{,}200$ min.)
Solving for the rate constant, k = -ln(0.5)/7,200 min = 9.63×10^{-5} min^{-1}
t reaction time = 2 minutes

$NO_{2min.}/NO_o = \exp(-9.63x10^{-5}\ min^{-1} * 2\ minutes) = 0.9998$

Amount of NO_2 created = $(1 - 0.9998) * (1 - 0.1) * 2{,}518.1\ \mu g/m^3 = 0.45\ \mu g/m^3$

Total 1-hour NO_2 impact:

Impact of NO_2 directly emitted + Amount of NO_2 created

$= 251.8\ \mu g/m^3 + 0.45\ \mu g/m^3 = 252.3\ \mu g/m^3$

Estimated NO2 Concentration versus Distance from Construction Area

Approximate Center of Construction Area

UTM X 239122 UTM Y 4014291

Rate Constant (min. $^{-1}$) = 9.63E-05

Transit time based on 1 m/s wind speed

Receptor Location			ISCST3 NOx	Distance from	Transit	NO_2/NO_x	Adjusted NO_2
UTM X	UTM Y	Elev. (m)	Conc. (μg/m3)	Source (m)	Time (min.)	Ratio	Conc. (μg/m3)
238975	4014325	68.60	2518.1	151	2.52	2.43E-04	252.3
239600	4013900	67.40	1257.5	617	10.29	9.90E-04	126.8
239800	4013300	67.00	659.0	1,201	20.01	1.93E-03	67.04
240000	4012000	66.40	383.0	2,453	40.89	3.93E-03	39.65
242000	4012000	62.80	322.0	3,678	61.30	5.89E-03	33.90
234000	4019500	75.00	113.4	7,306	121.76	1.17E-02	12.53

References:

Flagan, R.C. and Seinfeld, J.H., 1988. Fundamentals of Air Pollution Engineering. Prentice-Hall, Inc.

Williamson, S.J., 1973. Fundamentals of Air Pollution. Addison-Wesley Publishing Company, Inc.